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A NEW SPECIES OF TREEFROG FROM THE SERENGETI
NATIONAL PARK, TANZANIA (ANURA: HYPEROLIIDAE:
HYPEROLIUS)

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A remarkable new rough-skinned, rock-dwelling species of the genus *Hyperolius* (Hyperoliidae) is described from Serengeti National Park, Tanzania. The new species is not related to the other rough-skinned *Hyperolius tuberculatus* of West Africa, nor to the sympatric *Hyperolius viridiflavus goetzi*.

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The Hyperoliidae is the dominant treefrog family of Africa. Members of this monophyletic family (Drewes, 1984), consisting of 226 species in 20 genera, also occur on Madagascar and in the Seychelles Islands.

The sedge frogs, genus *Hyperolius* Rapp, with over 100 species are the most numerous of the hyperoliids (Duellman, 1993). They are found throughout the Afrotropical Region in all suitable habitats except true desert. Schiøtz (1971) stated that the genus *Hyperolius* "seems to be in the process of rapid evolution with a vast number of morphologically very similar species, many of which show much variation and tendency to geographical splitting up," and Drewes (1984) characterized the genus as in a "state of evolutionary flux." In two major works on African treefrogs, Schiøtz (1967, 1975) treated the West and East African species known at the time. He provided descriptions, photographs, sonograms, distribution maps and natural history information available at the time. South African members of the genus were treated separately in a monograph on South African frogs by J. C. Poynton (1964) and

central African species recently by Poynton and Broadley (1987).

Diversity within the genus *Hyperolius* is partly illustrated by proposed taxonomic changes within the past few decades. For instance, *H. thomensis* Bocage, 1886 has been moved in and out of the genus *Hyperolius* for a number of years (Perret, 1976, 1988; Drewes, 1984). In 1988, Perret removed three other species from the genus *Hyperolius* and placed them in three new genera. Recent unpublished morphological work by L. Henwood, California Academy of Sciences (CAS) added additional support to Schiøtz's contention (1975) that *Hyperolius parkeri* Loveridge does not fall within the currently recognized definition of the genus.

During the course of a 1992 photographic safari in Serengeti National Park, Tanzania a single adult female *Hyperolius* of strikingly cryptic appearance was discovered on Gong Rock, a famous boulder on an isolated inselberg known as Moru Kopjes in the southern sector of Serengeti National Park. Permission was granted by Tanzanian wildlife authorities for a subsequent visit

to Serengeti in May of 1993 during the rainy season. At that time, an additional four juveniles were collected; of these, two were deep-frozen for work in progress on the *Hyperolius viridiflavus* complex and two were preserved as voucher specimens. No additional adults have been collected thus far; the male advertisement call remains unknown.

DESCRIPTION

Hyperolius orkarkarri n. sp. (Plate 1A, B; Fig. 1)

HOLOTYPE.—CAS 186087 female; TANZANIA: Mara Region: Serengeti Dist: Serengeti National Park: Moru Kopjes, on Gong Rock. 02° 43.05'S; 34°47.6'E at an elevation of 1585 m. Collected by R. C. Drewes and C. M. Burnette, 24 July 1992 at approximately 1200 hrs.

PARATOPOTYPES.—CAS 191486-7 (juveniles); same locality as holotype. Collected by R. C. Drewes, M. T. Mendonca, E. Blankenship, B. C. Drewes and A. Fetter, 13 May 1993, 1525-1625 hrs.

DIAGNOSIS. — Differs from all other members of the genus *Hyperolius* by the extreme verrucosity of the dorsal and lateral surfaces of the body and limbs, and differences in size of the eye, finger and toe pads and amount of webbing between the toes.

ETYMOLOGY. — This species is named in honor of the Maasai, nomadic pastoralists who inhabited the Serengeti before it was gazetted a national park, and who used Gong Rock for ceremonial purposes. *Orkarkarr* is the *Maa* word for "gong."

DESCRIPTION OF THE HOLOTYPE. — Female, 21.1 mm snout-vent length; habitus squat; snout blunt; eye small, not protruding, its diameter less than distance to tip of snout and less than width of interorbital space; tips of fingers and toes dilated, truncated anteriorly, forming a flattened horizontal oval shape; third fingertip less than 1.5 times the diameter of eye; webbing of fingers reduced to a fringe except between third and fourth finger which is 1/3 webbed; toes fully webbed, web extending to or beyond distal subarticular tubercle except between first and second toes.

All dorsal and lateral surfaces of body, including the supraocular region, and exposed surfaces of limbs densely beset with warts of various sizes, so that nowhere is the skin smooth; the largest warts are isolated in the sacral region at approximately the level of the lateral extent of the sacral diapophyses, those on the left side nearly 1/2 diameter of the eye, those on the right side slightly smaller; the next largest are in roughly longitudinal dorsolateral rows extending from behind the eyes to the sacrum, followed by somewhat smaller tubercles arranged in two nearly parallel paravertebral rows extending from the snout to the anus; warts extend laterally onto the eyelids and superciliary region and ventrally to the canthal regions (Fig. 1).

Dorsal light pattern in the form of a broad band extending from tip of snout to above tip of urostyle, interrupted by a darker triangle on the head, the apices of the base extending laterally to the edges of the eyelids, the posterior extent of the apex to a distance roughly equal to equal the diameter of the eye. Three pairs of lateral extensions of the dorsal light pattern present, the anterior-most projecting diagonally forward from the scapular region to above the eyes, a large medio-dorsal saddle extending laterally, then posteriorly on the flanks, and a posterior pair extending laterally from the area above the pelvic region onto the flanks. An elongated mid-dorsal smudge of darker pigment present; the flanks and remaining lateral surfaces darker (Fig. 1).

Forelimbs with a light oval spot extending from wrist halfway up the forearm; hind limb with a large light oval extending from heel halfway up the tibiofibula; a light patch on the dorsal surface of the foot above the approximate origin of the metatarsals. The light oval on the tibiofibula is confluent with the posterior portion of the light dorsal pattern when frog is at rest.

Ventrum semitranslucent medially; all areas of the belly beset with verrucae hydrophilicae (Drewes et al., 1977); a transverse gular fold present.

Color in life (Plate 1A). Iris silver; dorsal pattern white on ground color of silver-grey. Finger tips, toe tips, fingers, toes and ventral surface of hind limbs dark orange; throat and ventrum white.

Color in preservative. Light dorsal and limb patterns fade to beige, ground color to medium



A



B



C



D

PLATE 1. A. Type: *Hyperolius orkarkarri*, CAS 186087 female, in life.
 B. Type *in situ* on north face of Gong Rock just prior to collection.
 C. Paratype, CAS 191486, just prior to collection.
 D. Paratype, CAS 191487, just prior to collection.

brown; dark orange coloration of extremities fades to white.

VARIATION IN PARATYPES. — CAS 191486-87, 18.7 and 20.3 mm. snout-vent length respectively, are both juveniles and agree well with the description of the holotype. In the former, the color pattern and distribution of warts are nearly identical to the holotype; although the two large warts in the sacral region appear smaller than in the holotype, they are still the largest relative to all other warts in dorsal aspect (Plate 1C). In CAS 191487 the warts are somewhat smaller than in the type and other paratype but still obvious and

distinct from all other *Hyperolius* material examined. Moreover, the dorsal color pattern (Fig. 1) differs in that the posterior apex of the dark triangle on the head narrows and extends posteriorly to the sacral region, giving the specimen a striped appearance (Plate 1D).

One additional specimen exists in the collection of the Serengeti Research Institute at Seronera that is probably referable to *Hyperolius orkarkarri*. The unnumbered specimen was collected by D. Kreulen at Galen's Drift, Serengeti and briefly examined by the author. As no curator nor other individual in a position of authority was

present during the author's visit (12 May 1993), the specimen was unavailable for loan.

COMPARISONS. — The type material of *H. orkarkarri* was compared with all of Schiøtz' (1975) material referable to *Hyperolius viridiflavus goetzi* Ahl with which *H. orkarkarri* is apparently sympatric and seemingly syntopic. In 1993, the nearest population of calling *H. v. goetzi* was located 1.9 km west of Gong Rock, and a single juvenile *H. v. goetzi* (CAS 191488) was collected on Gong Rock along with the paratypes of *H. orkarkarri*. Additionally, although the possession of heterogeneous dorsal warts is unique to this species, the dorsal color pattern of *H. orkarkarri* is somewhat similar in shape to one of the juvenile color phases (Ph J) exhibited in some subspecies of *H. viridiflavus* (Schiøtz, 1971).

Hyperolius viridiflavus goetzi differs from *H. orkarkarri* in its generally smooth dorsal and lateral skin, absence of a dorsal pattern, absence of dark orange coloration on the extremities and presence of dark spotting or marbling on the flanks (diagnostic of this taxon). In *H. v. goetzi*, the eye is larger than in *H. orkarkarri*, being roughly equal in diameter to the interorbital distance and the distance from the anterior margin of the eye to the tip of the snout. In *H. orkarkarri*, the diameter is less in both dimensions. In both species, the horizontal oval configuration and size of the finger and toe pad expansions are similar.

Hyperolius orkarkarri was also compared with series of *Hyperolius tuberculatus* (Mocquard) (including the type) and *H. t. nimbae* Laurent. A West African form, *H. tuberculatus* is the only other *Hyperolius* species whose type description includes tubercles and verrucose dorsal skin (Mocquard, 1897). Moreover, examination of West African material was deemed necessary because J.-L. Perret (MHNG) sent the author a photocopy of a photograph taken by A. Schiøtz (ZMUC) of a treefrog from Ivory Coast identified as *H. t. nimbae*, whose skin is remarkably similar to that of *H. orkarkarri*, including verrucosity on the limbs (although significant differences such as size of finger and toe pads are also apparent in the photo). The origin and identity of this specimen is in doubt, as it cannot be located with certainty in the ZMUC collection (J. B. Rasmussen, pers. comm.). Perret also sent a

photo by J.-L. Amiet of a treefrog from Pont de So, Cameroon; evidently a much larger species but equally verrucose, this specimen remains unidentified and its whereabouts unknown.

Hyperolius tuberculatus (including *H. t. nimbae*) is a much smoother species than *H. orkarkarri*, although in many specimens there are scattered low warts, usually a few on the dorsum in the occipital region and on the posterior portions of the flanks. These are generally of uniform size unlike *H. orkarkarri*, and none approach the largest in the latter species in size. In none of the material examined are there verrucosities on the supraocular regions nor on the exposed surfaces of the limbs as in *H. orkarkarri*. *H. tuberculatus* and *H. t. nimbae* differ from both *H. orkarkarri* and *H. v. goetzi* in possession of much larger digital tips that are rounded, not truncated anteriorly; the width of the third finger tip is more than 1.5 times the diameter of the eye; the hands are extensively webbed (nearly half webbed between 2nd and 3rd fingers). The diameter of the eye is greater than its distance to the tip of the snout, and the interorbital distance. Many specimens have a conspicuous white spot on the upper jaw below the eye, not present in *H. orkarkarri* nor *H. v. goetzi*.

DISCUSSION

Much of Serengeti National Park is classified as "edaphic grassland on volcanic soils" and lies within the more widely distributed *Acacia-Commiphora* bushland vegetation zone (White, 1983). Annual rainfall is variable in the park, but 20 year data from Ikoma, near the northern margins, indicate a mean annual rainfall of 862 mm and mean annual temperature of 19.1°C. (Wernstedt, 1972). For the five year period January 1988 to January 1993, rainfall at Moru Kopjes averaged 64.5 mm per month (K. Campbell, pers. comm.).

The Gong, from which this inselberg within Moru Kopjes takes its name, is a large lemon-wedge shaped boulder which lies on its rounded surface on top of the main massif (Plate 2 A). The thin edge of the Gong is aligned in an east-west attitude. This large boulder is famous for its resonance when struck with a small rock and was evidently used in the past to signal the beginning of Maasai ceremonies—it's north and south-

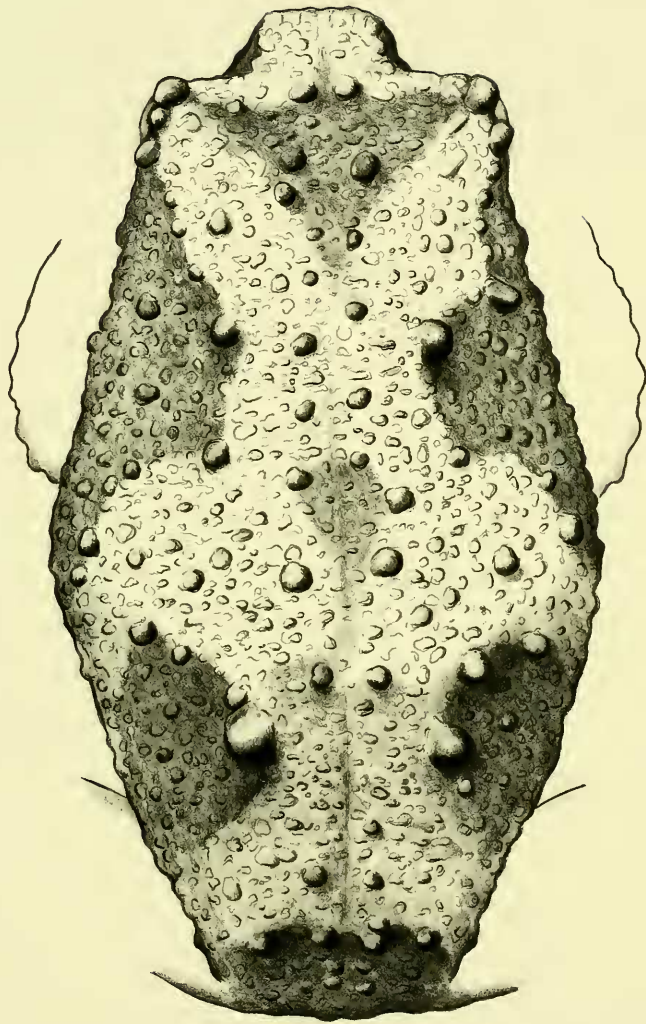


FIGURE 1. Dorsal pattern and distribution of warts in holotype.

facing surfaces are beset with linear rows of uniform, man-made, cup-shaped depressions. Larger boulders of the inselberg are decorated with recent pictographs. The type of *H. orkarkarri* was discovered in full sunlight in one of the depressions in the top row on the north face of the Gong. The following year, the first paratype, CAS 191486 (Plate 1C), was also found on the Gong itself, but in a depression on its south face (Plate 2B); CAS 191487 was taken from a vertical crevice in a nearby boulder about 1.5 m above the ground. The color pattern and texture of the skin very closely approximate the general aspect of the rock on which the specimens were collected (Plate 1B, C, D). Two additional specimens, presently frozen, were found in vertical crevices above wet seepage areas at the west base of the main massif, at grass level. The specimens were found in association with several *Chiro-mantis*, possibly *C. petersii* Boulenger, numerous *Agama*, and one example of *Hyperolius v. goetzi*.

Although most treefrogs are thought to seek shelter from desiccation during the daylight hours, the fact that the type specimen was discovered at rest in full sunlight is not too surprising. The South African Arum frog, *Hyperolius horstocki*, has long been known to rest in exposed positions (Wager, 1965), and recent work by Withers et al. (1982, 1984) and others has shown that all members of the genus *Hyperolius* tested so far exhibit much lower rates of evaporative water loss than would be predicted for treefrogs of their size. A dermal mechanism that might account for these observations has yet to be discovered.

The systematic relationships of *Hyperolius orkarkarri* are unclear, and will not be determined until a comprehensive phylogeny of *Hyperolius* is produced. *Hyperolius orkarkarri* shares a few of the characteristics diagnostic of the "*Hyperolius viridiflavus* group," such as the shape of the snout, shape of the dorsal pattern, and the presence of a gular fold. Moreover, it is in apparent sympatry with one of the group's purported members, *H. viridiflavus goetzi*. The morphological and behavioral characters that unite the *viridiflavus* complex are listed by Schiøtz (1971): snout brief ("pug-nosed"), digital webbing extensive, vocal sac and gular gland very large relative to snout-vent length, and females often with a transverse gular fold. In addition,

eggs are deposited in water (unlike most other *Hyperolius*), post-metamorphs are exceptionally large relative to adult size, and the group has a distinctive call. None of these characters has been demonstrated to be apomorphic, and much of the taxonomic work on this complex at the population (subspecies) level has been based on dorsal color-pattern analysis.

Although there are many taxonomic problems within *Hyperolius*, with its 112 recognized species, the *viridiflavus* complex is most important because of its great geographical range, the ubiquitousness and size of its populations, and its confused taxonomic history. There are four reasons for more than a century of taxonomic confusion, resulting in the publication of more than 100 nominal subspecies as of 1971 (Schiøtz): (1) the members of this complex are widespread in tropical savannas; (2) where present, populations are large and usually a conspicuous component of any breeding anuran aggregations; and (3) though members of the group share a number of morphological and behavioral characters, (4) they are highly variable in dorsal color pattern, both within populations and between them.

The fact that a new species of treefrog can exist, undiscovered, on a famous rock in the middle of the Serengeti National Park—possibly the most intensively studied ecosystem in tropical Africa—is far less surprising than it is regrettable. The overlooked existence of *Hyperolius orkarkarri* in Serengeti reflects the fact that for years the great majority of effort, support and funding for species-level biological work has been applied toward ecological and behavioral studies, and these are usually of mega-vertebrates such as bovids, carnivores and primates. Meanwhile, the arthropod and smaller vertebrate faunas have been almost totally neglected, and while these are just as ecologically important (if not more so) as the large mammal and bird faunas, they remain very poorly understood. The past funding trend reflects the profound misunderstanding that these habitats and their species are already fully documented and well-understood. This is far from the case. In truth, the behavior and ecology of the Serengeti mega-fauna is available for study only because these conspicuous species have already been described by systematists and their evolutionary relationships clarified to some degree.

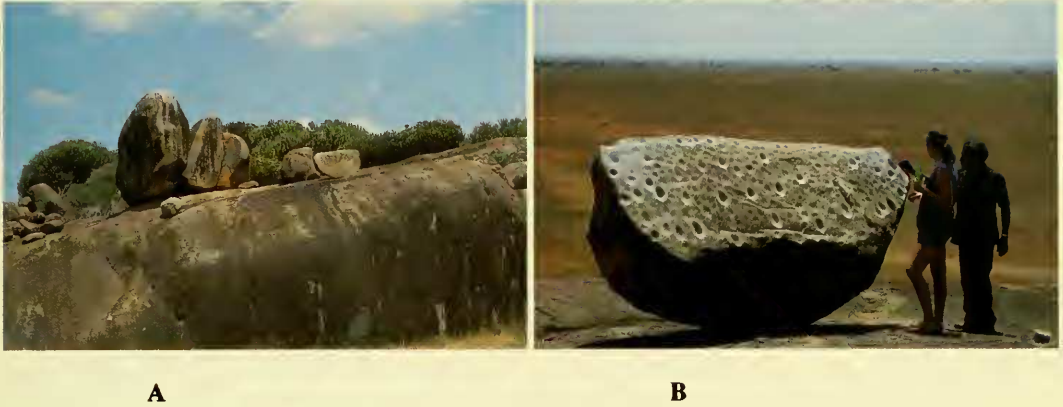


PLATE 2. A. Gong Rock on Moru Kopje. The Gong is the lighter colored structure on the right
B. Southern aspect of Gong Rock; paratype CAS 191486 was collected on this face.

It is true that as awareness of environmental problems has grown on a world-wide scale, African governments have begun to pay more attention to habitat issues, especially those that directly affect economies and attract significant monies from non-governmental organizations. There has been much global media attention to “vanishing habitats,” and perhaps as a result, we are beginning to meet African students who see careers in biology as viable options. Most unfortunately, opportunities to train in systematic biology, the foundation for all other biological disciplines, are almost nonexistent, and most of the students we know have trained in ecology or ethology. Like the rest of the world, Africa needs more systematists.

MATERIAL EXAMINED

Museum acronyms follow Leviton et al. (1985).

Hyperolius viridiflavus goetzi: Tanzania: CAS 191482–5 near Moru Kopjes, CAS 191488 Gong Rock; ZMUC RO 76959–63 Seronera; ZMUC RO 79440–4 Dabaga; ZMUC RO 79064–70 15 m. E. Sao Hill; ZMUC RO 78885–7, 78889–904 E. Singida.

Hyperolius tuberculatus tuberculatus: Gabon: Type — MNHN 1896.570 Lambarene; Topotypes — MNHN 1901.576–7; Cameroon:

MNHN 1994.5748; BMNH 1937.12.1.29–30 Lomi Dist; BMNH 1908.5.30.67–69, 1909.12.3.17, 1913.10.29.26, Bitye; BMNH 1907.5.22.94 5 mi. inland from Kribi; BMNH 1906.5.28.115–118 Zima Country; BMNH 1904.2.29.12 Efulen. Zaire: CAS 145286–7 Gembe; BMNH 97.9.30.6–10 Stanley Falls; MNHN 1988.1307–31 Maniema, Kalima; MNHN 1988.1246–94 Kamituga; BMNH 1952.1.5.77 Kamituga. Nigeria: BMNH 1938.1.11.4–8 Uyo. Equatorial Guinea: BMNH 1977.2.132–41, 2142–4, 2156–60 Fernando Po, Largo de Biao.

Hyperolius tuberculatus nimbae: Ivory Coast: ZMUC RO 75461, 66, 70, 74, 79 between Zeale and Denane.

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